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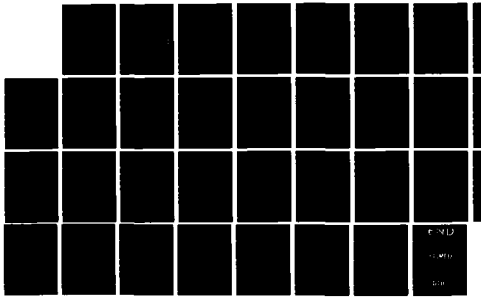

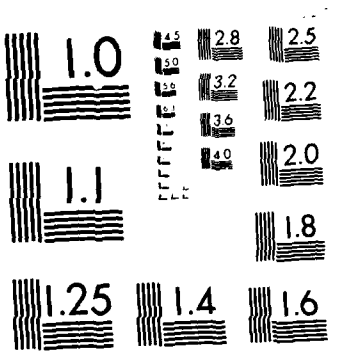

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AD-A156 890

VALIDATION OF THE ALGORITHM FOR BASE TCTO LABOR COST FOR THE COMPONENT SUPPORT COST SYSTEM (D160B)

Contract No. F33600-82-C-0543

15 August 1983

Report Number
V-83-31859-01

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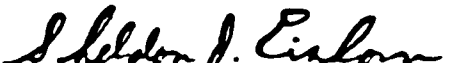

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EXECUTIVE SUMMARY

Visibility and Management of Operating and Support Costs is a program initiated by the Office of the Secretary of Defense (OSD) in order to ensure that each Military Department gathers, tracks, and computes operating and support costs by weapon system. VAMOSC II is an Air Force management information system which is responsive to the OSD initiative. It uses information from existing Air Force data systems to satisfy both Air Force and OSD needs for certain weapon system operating and support (O&S) costs.

At present, the VAMOSC II system comprises three subsystems:

(1) The Weapon System Support Cost (WSSC) system (D160), which deals with aircraft,

(2) The Communications - Electronics (C-E) system (D160A), which deals with ground communications - electronics equipment,

(3) The Component Support Cost Subsystem (CSCS) (D160B), which deals with subsystems and components for aircraft.

The Component Support Cost System (CSCS) of VAMOSC II gathers and computes support costs by assembly/subassembly and relates those costs back to the end item or weapon system. CSCS replaces the Logistic Support Cost (LSC) model of K051 (AFLCR 400-49) for aircraft and engines.

The CSCS receives inputs from 15 Air Force data systems. On a quarterly basis, the system provides two standard reports each processing cycle and twelve other types of reports as requested by users. It also provides pre-programmed data base extracts on magnetic tape on a one-time basis in response to user requests.

Special requests for data in user selected format may also be satisfied on a case by case basis.

At the heart of the CSCS is a set of 30 algorithms for estimation or allocation of costs. Information Spectrum, Inc. (ISI) was awarded a contract to validate these algorithms. This effort included investigations of logic, appropriateness of the algorithms and assumptions inherent in the algorithms. ISI was also to survey published findings, reports of audit, etc. relating to the accuracy of the source data systems. In addition to the algorithm validation, ISI was to perform certain "special tasks," including a user survey.

This report provides the verification and validation of the algorithm called "Base TCTO Labor Costs." The costs of direct labor performed in maintenance of aircraft is a major component of support costs. This maintenance includes activities in response to Time Compliance Technical Orders (TCTOs), which are "directives issued to provide instructions to Air Force activities for accomplishing 'one-time' changes, modifications, or inspections of equipment or installation of new equipment." (Reference [12]). The CSCS algorithm for Base TCTO Labor Cost calculates and presents TCTO labor costs separately from other direct labor costs. These costs are developed for each combination of aircraft MDS and base.

The algorithm is simple in concept: The appropriate labor hours are summed and the result is multiplied by a labor cost rate. This labor cost rate is of added significance because it is also used in several other cost algorithms.

In order to verify and validate the CSCS algorithms, a set of analysis procedures applicable to all of the algorithms was established. These procedures were than applied to each algorithm. This report first describes the analysis procedures, without reference to the specific algorithm addressed by this report.

Next, the Base TCTO Labor Cost algorithm is defined and described in detail. This description includes identification of source data systems and files, and the calculation procedures currently implemented by the CSCS.

Finally, a critique of the algorithm is provided as required by the contract. It addresses the following topics:

- Verification of assumptions and approximations for appropriateness and accuracy.
- Validation of accuracy of source data.
- Validation of appropriateness of source data as inputs to CSCS logic.
- Investigation of accuracy and appropriateness of algorithms.
- Consideration of replacement of indirect cost methods with more direct ones.
- Identification of algorithm impact on CSCS output reports.

For each algorithm addressed, ISI is required to affirm the process or procedure and reject any portion that cannot be affirmed. Where the algorithm or portion of the algorithm is rejected, an alternate procedure must be specified.

The following defects in the Base TCTO Labor Cost algorithm have been noted.

(1) A military labor rate is multiplied by a sum of military and civilian labor hours.

(2) Annual inflation factors are applied once at the beginning of the fiscal year.

(3) Adjustment of labor rates on the basis of inflation factors becomes increasingly inaccurate as time elapses. No explicit provision is made for recognizing or correcting the inaccuracy.

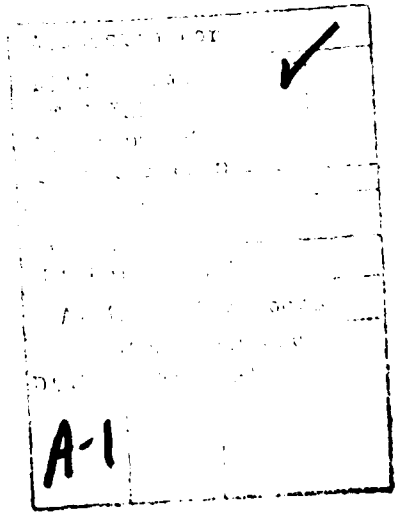
In addition to these flaws, the report notes a problem in accuracy of input data systems. Published reports indicate that manhour data provided by the Maintenance Data Collection System is significantly deficient in both accuracy and timeliness. These deficiencies, if left uncorrected, would tend to negate the usefulness of the algorithm. However, the Air Force is currently testing a new system, the Automated Maintenance System, with considerable promise of correcting the deficiencies.

Three recommendations are provided for correcting the flaws in the algorithm. The first entails providing to the CSCS separate manhour data for civilian and military maintenance personnel. This would require changes in coding reports within the Maintenance Data Collection System, in processing these reports by the Product Performance System (D056), and in processing by the CSCS itself. In addition to providing more accurate labor costs, the recommendation would permit separate display of military and civilian base TCTO labor costs. The recommendation takes on added significance when it is recognized that it will apply to all base labor cost algorithms, not just to TCTO.

An alternative procedure is also offered. The alternative is less accurate and less useful, but simpler to implement. It

entails development, through a survey, of composite labor rates for each MDS. The composite rates would reflect an actual mixture of civilian and military manpower.

A simple adjustment procedure is recommended for changing annual inflation rates to values applicable to the quarter. This procedure would be manually implemented.



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1.0 INTRODUCTION

Visibility and Management of Operating and Support Costs is a program initiated by the Office of the Secretary of Defense (OSD) in order to ensure that each Military Department gathers, tracks, and computes operating and support costs by weapon system (all costs are computed and portrayed in "then year" dollars). VAMOSC II is an Air Force management information system which is responsive to the OSD initiative. It uses information from existing Air Force systems to satisfy both Air Force and OSD needs for certain weapon system operating and support (O&S) costs.

At present, the VAMOSC II system comprises three subsystems:

(1) The Weapon System Support Cost (WSSC) system (D160), which deals with aircraft,

(2) The Communications - Electronics (C-E) system (D160A), which deals with ground communications - electronics equipment,

(3) The Component Support Cost Subsystem (CSCS) (D160B), which deals with subsystems and components for aircraft.

1.1 The Component Support Cost System

The Component Support Cost System (CSCS) of VAMOSC II gathers and computes support costs by assembly/subassembly and relates those costs back to the end item or weapon system. CSCS replaces the Logistic Support Cost (LSC) model of K051 (AFLCR 400-49) for

aircraft and engines.

The objectives of the Component Support Cost System are:

(1) To improve the visibility of aircraft and engine component support costs and to relate those costs to the end item or weapon system.

(2) To improve the Life Cycle Costing capability for the Air Force and the Department of Defense in the acquisition of new weapon systems.

(3) To assist in the design of new weapon systems by providing cost information on existing weapon systems, thereby enhancing design tradeoff studies.

(4) To provide historical cost information at the weapon system level to improve logistic policy decisions.

(5) To identify system component reliability, effectiveness, and costs so that high support cost items may be identified and addressed.

The CSCS is described in detail in references [1], [2], and [3]. It receives inputs from 15 Air Force data systems. On a quarterly basis, the system provides two mandatory reports each processing cycle and twelve other types of reports as requested by users. It also provides pre-programmed data base extracts on magnetic tape on a one-time basis in response to user requests. Special requests for data in user selected format may also be satisfied on a case by case basis.

The twelve reports mentioned above are of primary interest

to the user community. They are identified by name in Table 1. Descriptions and samples are provided by reference [1].

TABLE 1. CSCS OUTPUT REPORTS

NUMBER*	Name
8105	Cost Factors
8104	MDS Logistics Support Costs
8106	Base Work Unit Code (WUC) Costs
8107	Total Base Work Unit Code (WUC) Costs
8111	Depot On-Equipment Work Unit Code (WUC) Costs
8108	Total Base and Depot Work Unit Code (WUC) Costs
8109	NSN-MDS-WUC Cross-Reference
8110	MDS-WUC-NSN Cross-Reference
8112	Logistic Support Cost Ranking, Selected Items
8113	Summary of Cost Elements
8114	NSN-WUC Logistics Support Costs
8115	Assembly-Subassembly WUC Costs

*CSCS output reports are assigned Report control Symbol HAF-LEY (AR)nnnn, where nnnn is the number in the table.

At the heart of the CSCS is a set of 30 algorithms for estiıation or allocation of costs. The algorithms are identified by ıame in Table 2. Information Spectrum, Inc. (ISI) was awarded a ;ontract to validate these algorithms. This effort included .nvestigations of logic, appropriateness of the algorithms and ıssumptions inherent in the algorithms. ISI was also to survey ›ublished findings, reports of audit, etc. relating to the ıccuracy of the source data systems. In addıtion to the ılgorithm validation, ISI was to perform certain "special tasks," including a user survey.

1.2 Overview of the Algorithm

This report provides the verification and validation of algorithm 1 of Table 2, "Base TCTO Labor Costs." The cost of direct labor performed in maintenance of aircraft is a major component of support costs. This maintenance includes activities in response to Time Compliance Technical Orders (TCTOS), which are "directives issued to provide instructions to Air Force activities for accomplishing 'one-time' changes, modifications, or inspections of equipment or installation of new equipment," (Reference [12]). The CSCS calculates and presents TCTO labor costs separately from other direct labor costs. These costs are provided separately for each combination of aircraft MDS and base.

The algorithm, as will be seen, is simple in concept. The appropriate labor hours are summed and the result is multiplied by a labor cost rate. This labor cost rate is of particular significance because it is also used in several other cost algorithms.

eport fields of the AFTO 349 do not require a pay rate. Also, ome maintenance actions require more than one man to accomplish, nd in these cases the total manhours for the group of people are eported. Again, the AFTO 349 form does not provide the capabi- ity to report a group of pay rates. The most appropriate accom- iodation to this fact of life is to apply an average pay rate, if ıvailable. Accordingly, ISI confirms that the algorithm is fun- lamentally sound, subject to the criticisms in Sections 3.2.2 and 3.2.3. Appropriate recommendations will be provided in Section 4.

3.2.5 Directness of Costing

This algorithm provides a direct costing methodology and a more direct costing methodology is neither possible or necessary.

3.2.6 Application to CSCS Output Reports

Base TCTO labor costs are components of five CSCS reports, as described by Table 3. The accuracy of the algorithm output will impact the accuracy of the reports as a whole. However, the total report accuracy cannot be addressed until all algorithms are reviewed. This will occur in the final report of this effort. Evaluation of the usefulness of the report will also be provided in the final report of this effort and after ISI conducts a survey of users.

in between. ISI finds the lack of congruence between the definitions of inflation rate as provided by the input system and as used by the CSCS unacceptable.

3.2.3 Appropriateness of Source Data as Inputs

The need for TCTO manhours data as inputs to this algorithm is self-evident. The D056 data accurately reflects the data logged by maintenance personnel. No other source of TCTO manhours data exists. Accordingly, ISI affirms the use of the D056 data as a source of TCTO manhours. It must be recognized, however, that improvement in source data accuracy is highly desirable, as discussed in Section 3.2.2.

The appropriateness of the average labor rates as adjusted by inflation is adequate at present, but it will deteriorate with time. The labor rates represent a mix of pay grades that were valid in 1980. This mix will lose validity as the Air Force manpower mix changes with time. The assertion of reference [1] that the labor rates will be recalculated "on an as required basis" is not supported by a definite methodology. For these reasons ISI finds the average labor rate currently used is inappropriate.

3.2.4 Accuracy and Appropriateness of the Algorithm

Ideally, each maintenance man would report the hours worked on TCTO (as well as on other jobs) and his pay rate. It would then be a trivial procedure to calculate the cost of direct TCTO labor. In practice, personnel do report the hours worked on direct TCTO labor through the MDCS but not their pay rates. The

There is congruence between the definitions of TCTO manhours as provided by the input data system and as used by the Base TCTO Labor Cost algorithm.

The next inputs considered are the labor rates that are applied to the TCTO manhours. Reference [7] provides military and civilian labor rates which were calculated for each MDS. The reference indicates that these rates were calculated using the same procedure as normally used by the Maintenance Cost System. Reference [16], however, indicated differently.

Resolution of the manner in which the rates were computed has not been resolved and will be reported in the analysis of subsequent algorithms. The manner in which these labor rates (regardless of their value) are applied is of some significance, however. The algorithm applies the labor rates to manhours which are the sum of military and civilian maintenance manhours. The rate applied, however, is the military labor rate. The civilian rates are not used. This lack of congruence distorts the algorithm results.

The final inputs are the inflation factors for military pay. These factors are based on accurate, well documented data, and ISI affirms their accuracy. There is, however, another problem in congruence of definition. The inflation factors provided by reference [15] apply to the midpoint of the year. The CSCS reports are quarterly, and it would be appropriate to use inflation factors scaled to the quarter. The current procedure applies a full year's worth of inflation to the transition from the end of one fiscal year to the beginning of the next, and none

short duration. Although this sample cannot be freely extrapolated to all maintenance events in the Air Force, there is no doubt about the significance of two of the findings.

First, of the maintenance events observed, only about half could later be identified among the reports in the Maintenance Data Collection (MDC) system, despite determined efforts. Note that this was an unexpected result for which the study had not been designed. The report does not give the explicit criteria which were used to identify a match. The second significant result was that for the maintenance events which could be identified, the manhours reported to the MDC system averaged about twice as much as the quantities recorded by the study personnel.

The Air Force is testing an automated system which holds promise of considerably improving the accuracy of reporting of maintenance manhours. This system, called the Automated Maintenance System (AMS), provides for real time, automated input, editing, and retrieval of data of the MDCS. The AMS is currently being tested at Dover AFB. The GAO report does not provide direct evidence of improved accuracy provided by the AMS, but it cites impressive improvements in the number of maintenance actions reported as completed. It also indicates that Air Force officials believe that the AMS virtually eliminates inaccuracy in MDC data.

On the basis of the published reports, ISI concludes that manhours data provided by the D056 system is at present generally subject to significant errors, with direct adverse impact on the accuracy of the output of the algorithm.

audit, etc. No direct sampling of data was to be performed. The Office of VAMOSC has indicated that direct validation of source data is planned for future efforts.

The source data consists of manhours provided by the Product Performance System (D056), labor rates for FY 80 provided on a one-time basis, and inflation factors published annually by the Air Force.

Published reports such as references [10] and [11] indicate that manhours data provided by D056 are quite inaccurate. The data in D056 are sent to it by each base, through a system known as the Maintenance Data Collection System (MDCS). The MDCS, in turn, gets its data from forms filled out manually by maintenance personnel. MDCS data have been assailed as plagued by inaccuracy and lack of timeliness. Reference [11], known in Air Force VAMOSC circles simply as "the GAO report," provides indictment of the MDCS data and suggests that systems based on it will not be believed or much used by the maintenance community. The GAO report often relies on small samples, and it is more anecdotal than scientific. Nevertheless, as a whole it is convincing.

One study, whose results are incorporated (though not explicitly identified) in the GAO report, is provided by reference [10]. This study, conducted in the fall of 1978, was concerned with the accuracy of base maintenance manhours reported by the MDCS. The study was restricted to two Tactical Air Command bases, and a total of 119 maintenance events, selected to be of

1980 are the same as the average for all maintenance in 1980. The second is that the rate of inflation for TCTO labor is the same as the rate applicable to military manpower cost in general.

Addressing the first assumption, our experience suggests that on the average, repair requires more highly skilled labor than TCTO does, while routine servicing requires less skill. This argument, admittedly very indirect, suggests TCTO labor rates should lie near the average, and therefore application of the average labor rate for all maintenance is reasonable in this algorithm. ISI can see no feasible approach to a more direct verification of this assumption.

The second assumption concerns whether inflation factors for TCTO labor rates might differ significantly from those for all military personnel. ISI analysts have tracked various inflation indices for many years. Our experience indicates that differences between indices for similar quantities are invariably negligible.

Accordingly, ISI affirms the appropriateness and accuracy of assumptions and approximations incorporated in this algorithm.

3.2.2 Accuracy of Source Data and Congruence of Data Element Definitions

Information Spectrum was directed to validate accuracy of

3.1.3 Description of Calculation Procedure

D056A File MNI70K0 and D056C File MIP15K0 is received monthly. Records include SRD, base code, and both on-equipment and off-equipment TCTO manhours (as well as other data) (Reference [6.9]). SRDs are converted to MDS using internal CSCS tables. The program recognizes engine SRDs, and identifies the associated aircraft MDS. For each MDS-base combination, the program sums all on-equipment and off-equipment TCTO manhours reported for the calendar quarter. The result is multiplied by the direct labor rate for the MDS.

3.2 Critique of Algorithm

This section addresses various facets of the algorithm. The discussion is structured to correspond to the contractual requirements. Each aspect is either affirmed or rejected. Rejections lead to recommendations in Section 4.0.

3.2.1 Appropriateness and Accuracy of Assumptions and Approximations.

Information Spectrum has identified two assumptions or approximations (either term is appropriate) implicit in the algorithm. The first is that average labor rates for TCTO in

3.1.1 Calculations

MDS-BASE-TCTO-LABOR-COST = (MDS-BASE-TCTO-MH-ON
+ MDS-BASE-TCTO-MH-OFF) x DLR-MDS

3.1.2 Inputs

Name: MDS-BASE-TCTO-MH-ON

Definition: Inspection manhours reported for the MDS, base, and calendar quarter.

Source System/File: D056A/MNI70K0

Name: MDS-BASE-TCTO-MH-OFF

Definition: Off-equipment TCTO manhours reported for the MDS, base, and calendar quarter.

Source System/File: D056C/MPI15K0

Name: DLR-MDS

Definition: Average direct military labor rate for maintenance for the MDS

Source: Reference [7] provides average direct labor rates for FY 80 for each MDS. The military rates are inflated annually by the CSCS by multiplying the applicable annual inflation index for military manpower cost (referred to FY 80 as a baseline), published annually in AFR 173-13. According to reference [1], rates will be recalculated on an as required basis. No procedure has been established for determining when or how to recalculate the rates.

3.0 ALGORITHM ANALYSIS

The previous section described the general analysis procedures applied to all algorithms. This section presents the results of applying those procedures to the algorithm for Base Labor Costs.

Section 3.1 provides a detailed description of the algorithm and of the input data it uses. Section 3.2 provides a critique, structure to correspond to the contractual requirements. Section 4.0 makes recommendations for solutions of problems.

3.1 Algorithm Description

In the following description COBOL-type data names are used to express the algorithm output and its components. The available source documentation does not provide the actual data names used by the CSCS programs. They are presumably different from those used in this report.

This description provides a formula for the calculation that is derived from the Users Manual and other sources. It is not the same as the formula provided in the Users Manual. It is intended to be more explicit. The formula is stated in Section 3.1.1. The input data elements and their sources are provided in Section 3.1.2. The calculation is described verbally in Section 3.1.3. Unless otherwise noted, the descriptions are based on references [1], [2], and [3], and on direct discussion with personnel of the Office of VAMOSC. In case of any discrepancies, information provided by knowledgeable personnel was accepted as most current, hence most definitive.

2.4 Problem Resolution

Whenever a significant deficiency was recognized in one of the algorithms, one or more proposed solutions were developed. This was a creative analytic process for which few guidelines could be proposed in advance. Certainly it depended on familiarity with the various existing Air Force data reporting and processing systems. Proposed solutions were discussed with personnel of the Office of VAMOSC, and revised as appropriate. Recommended solutions were expressed in the form of contributions to a draft Data Automation Requirement (DAR) when these would be applicable.

2.5 Documentation

The documentation of the analysis of each algorithm was a crucial part of the effort. Emphasis was placed on making it thorough, clear, and unambiguous. In the documentation, every assertion was substantiated. This was done by reference to source documentation, by explicitly expressed application of the experience and judgment of the contractor, or by citation of information provided by cognizant Air Force personnel. In the last case, the information was supported by documentation identifying the source, the date, and the information provided.

(e) Test the algorithms under conditions of assumed extreme values for the inputs. For instance, in evaluating the algorithm for base maintenance overhead costs, assume that for a single reporting period all maintenance labor is overhead and none is direct. Also try the reverse assumption. If an assumption of an extreme input leads to an illogical result, the algorithm is flawed.

General Task (4) of Section C-2 of the contract speaks of appropriate statistical techniques to confirm or repudiate each algorithm. Statistical techniques could confirm or repudiate only statistical hypotheses as assumptions. (Use of an average does not constitute an assumption.) Accordingly, statistical techniques apply to confirmation or repudiation *of an algorithm* only to the extent that statistical hypotheses can be developed.

(f) As each algorithm is considered, ensure that the costs do not overlap others already accounted for. (In some cases an overlap may be necessary and desirable. Where this occurs, the overlap will be noted.)

(g) In each CSCS output report, identify the data elements incorporating the output of the algorithm, so that a final assessment of report accuracy can be made for each output report.

(h) Consider alternative sources of input data for the algorithm. Also consider more direct cost assignments than those incorporated in the algorithm.

Some explicit techniques which were generally used in concept validation are listed below.

(a) Consider how the cost element would be calculated if there were no contrainsts on resources. (For example, suppose the CSCS would identify the pay grade and hours worked of each individual involved in a maintenance action.)

(b) Identify assumptions* incorporated into the Algorithm. Generally this procedure will identify the real constraints which affect the approach in (a) above.

(c) Identify approximations incorporated into the algorithm. For instance, one such approximation is the use of an average labor rate for each aircraft.

(d) Study each approximation for possible sources of error. Some examples are biases introduced by editing procedures, obsolete data, or inappropriate application. Whenever feasible, estimate the likelihood of these errors by reviews of the literature and contact with cognizant personnel.

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* Note that assumptions, approximations, and allocations are different concepts, although in some cases the boundaries between them are not sharp. ISI has recognized few assumptions in the algorithms, but many approximations and allocations.

the definition of the input data. The identification of each input data element and of the system providing it was provided by the User's Manual (reference [1]). This identification was refined by identification of a particular file within the source system and the structure of the file as described in both the CSCS System/Subsystem Specification and in the Memoranda of Agreement. The Memoranda of Agreement have been established between the Office of VAMOSC and the Offices of Primary Responsibility (OPR) for the systems providing the input data. Any inconsistencies or voids were identified and resolved through contact with the Office of VAMOSC and/or implementing personnel.

Whenever appropriate, input data element definitions were further refined by tracing the elements back to their sources through the reference data provided. If these were inadequate, the OPRs were contacted directly for clarifications. In tracing the data back to their origins, possible sources of data contamination were considered. Information on the likelihood and significance of such contamination was collected from cognizant personnel and from published references.

2.3 Concept Validation

The two steps above established exactly what the algorithm does. The third, and most critical step, considered the validity of the procedure. It depended on the ability of the analyst to translate mathematical formulas and data processing techniques into meaningful concepts.

2.0 ANALYSIS PROCEDURES

In order to verify and validate the CSCS algorithms, a set of analysis procedures applicable to all of the algorithms was established. These procedures were then applied to each algorithm. This section describes the analysis procedures without reference to the specific algorithm addressed by this report.

The algorithm analysis process consists of five portions, described in the following sections.

2.1 Algorithm Description

The algorithms are described in references [1], [2], and [3]. These descriptions are not identical. In general they supplement, rather than contradict each other. The first two describe what the system is to achieve; the third describes the system design to do so.

None of these descriptions provides the combination of level of detail and clarity of concept required for this validation effort. The first step in the analysis methodology was the generation of such a description. The descriptions in the three reference sources just cited were studied. Assumptions about data processing procedures were made explicit. When necessary, Air Force personnel involved in implementation of the D160B subsystem were contacted for clarification.

2.2 Input Data Definitions

Closely related to the first step was the clarification of

TABLE 3

CONTRIBUTION OF BASE TCTO LABOR COST ALGORITHM TO CSCS OUTPUT REPORTS

OUTPUT REPORT/NUMBER(1)	COST ELEMENT CONTRIBUTED TO BY THE ALGORITHM(2)
1. MDS Logistics Support Cost/8104	1. By MDS for all bases a. TCTO costs-base labor costs b. Total MDS Costs
2. Base Work Unit Code (WUC) Costs/8106	2. By MDS for each base Total Base Costs, TCTO
3. Total Base Work Unit Code (WUD) Costs/8107	3. By MDS for all bases Total Base Costs, TCTO
4. Total Base and Depot Work Unit Code (WUC) Costs/8108	4. By MDS for all bases Total Costs, TCTO
5. Summary of Cost Elements/8113	5. By MDS for all bases a. Unit Mission Personnel (Maintenance) Organizational Costs, Base TCTO (On-Equip) b. Unit Mission Personnel (Maintenance), Intermediate Costs, Base TCTO (Off-Equip)

(1) CSCS output reports are assigned Report Control Symbol HAF-LEY (AR) nnnn, hwere nnnn is the number in the table.

(2) Capital letters indicated titles printed on reports.

4.0 RECOMMENDATIONS

Section 3 has presented ISI's judgement that the algorithm for base TCTO labor cost is fundamentally sound, but contains flaws in application. These flaws are summarized as follows:

(1) A military labor rate is multiplied by a sum of military and civilian labor hours.

(2) Annual inflation factors are applied once at the beginning of the fiscal year.

(3) Adjustment of labor rates on the basis of inflation factors alone becomes increasingly inaccurate as time elapses. No explicit provision is made for recognizing or correcting the inaccuracy.

Information Spectrum has developed two alternative recommendations in response to item (1). The first recommendation provides for separation of military and civilian TCTO base labor costs. It is discussed in Section 4.1. An alternative, which we consider less satisfactory, is discussed in Section 4.2. Section 4.3 addresses item (2) and recommends a simple improvement to the procedure for inflation adjustments. Item (3) is addressed in Section 4.4, which proposes a new approach to the determination of labor rates.

In the Air Force Logistics Command, changes to automated data systems are initiated through preparation of AFLC Form 238, "Data Automation Requirements," (DAR). This form contains a number of administrative entries, together with three items of substantive content: "Requirements," "Impact Statement," and "Justification

Benefits/Cost Savings." For each proposed data system change, ISI has provided a draft of these sections.

4.0a Office of VAMOSC (OOV) Comments

Concur.

4.1 Separate Civilian and Military Base Labor Costs

It is recommended that base TCTO labor costs be calculated and displayed separately for civilian and military labor. This would entail four separate changes. First, the Maintenance Data Collection System should be changed to forward manhours to AFLC separately for military and civilian labor. This change could be implemented as described by the DAR entries of Attachment 1. Next, the Product Performance System (D056) which receives the data should be changed to accept the new format. This change is described in Attachment 2.

The MOA and data input formats from D056 to the CSCS must be modified to include military and civilian maintenance manhours. The CSCS would then be modified to accept and process the data. These changes are described in Attachment 3.

4.1a Office of VAMOSC (OOV) Comments

Concur. We sampled Weapon System Support Cost (WSSC) data and found that only 2-3 percent of the total base maintenance squadron work force are civilians. Therefore, there is some question as to the utility of costing military and civilian labor separately. In addition, we do not expect the necessary changes

to the MDCS will be possible until FY86 when the Phase IV data system is implemented. In the meantime, we will further review the utility of capturing, from MDCS, miliary/civilian available hours for computing DLRs. At least until the review is complete, we will compute DLRs for each MDS using the MCS IA report. Each DLR will be a composite military and civilian rate, weighted based on the reported number of military and civilian hours.

4.2 Development of Average Labor Rates

The recommendations of Section 4.1 entail modifications to systems and procedures of long standing. Their implementation may prove unfeasible or unacceptable. An alternative recommendation is that the military labor rates currently being used by the CSCS be replaced for each MDS by a composite military and civilian labor rate and be applied to the composite manhours that are obtained by current procedures. This rate would be developed by identifying total civilian and military maintenance manhours for each MDS over a period of time (The most current four quarters is recommended). Then for each MDS the appropriate composite labor rate would be the result of weighting the civilian and military rates of reference [7] by these manhours.

This change would require no programming changes; hence no programming DAR would be required.

4.2a Office of VAMOSC (OOV) Comments

Concur.

4.3 Modified Inflation Factors

Inflation factors published in reference [15] apply to the middle of the fiscal year. In order to apply these to a fiscal quarter, a simple linear interpolation is recommended. Explicitly, let F(X) be the published inflation factor for fiscal year S, referred to FY80. Then

In the first quarter use [5 F(X) + 3F (X-1)]/8.

In the second quarter use [7 F(X) + F(X-1)]/8.

In the third quarter use [7 F(X) + F(X+1)]8.

In the fourth quarter use [5 F(X) + 3F (X+1)]/8.

These formulas are derived in Attachment 4.

For example, reference [15] lists an inflation factor of 1.318 for FY 82 and 1.418 for FY 83 for total military compensation. Accordingly, an appropriate factor for the second quarter of FY 83 would be (7 x 1.418 + 1 x 1.318)/8 = 1.4055.

Since the impact of inflation is entered into the CSCS manually, no DAR is required.

4.3a Office of VAMOSC (OOV) Comments

Concur. Please include a detailed explanation of how modified inflation factors are computed.

(SEE ATTACHMENT 4)

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[6] Memoranda of Agreement (listed separately)

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[22] TO-00-20-2-10, Technical Manual: Off-Equipment Maintenance Documentation for Shopwork, Conventional Munitions, and Precision Measuring Equipment, 1 January 1978, updated to 1 August 1982

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[53] "Validation of the Algorithm for Base Inspection Costs for the Component Support Cost System (D160B)," Information Spectrum, Inc., Report No. V-83-31859-04, 15 August 1983

MEMORANDA OF AGREEMENT
FOR SYSTEM INTERFACES

Ref. No.	Memorandum No.	Date
[6.1]	D002A/M024B/D160B-A	9 Jun 1980
[6.2]	D002A/M024B/D160B-B	9 Jun 1980
[6.3]	D024A/D160B-A	30 Jun 1980
[6.4]	D033./ARC/D160B	14 Jun 1980
[6.5]	D042A/DNB/D160B	4 Nov 1983
[6.6]	D046/M024/D160B	9 Apr 1981
[6.7]	D046/D160B	23 Jun 1982
[6.8]	D056A/BDN/D160B-A	23 Jan 1981
[6.9]	D056A/D160B-C	13 Oct 1981
[6.10]	D056A/D160B-D	29 Jan 1981
[6.11]	D056A F005	25 Apr 1979
[6.12]	D056B/BDN/D160B-A	22 Dec 1980
[6.13]	D056C/D160B-A	4 Mar 1981
[6.14]	D071/D160B	17 Jun 1982
[6.15]	D143B/D002A 9159	3 Aug 1979
[6.16]	D143F/ARC/D160B-A	5 Feb 1981
[6.17]	D160/D160B	11 Jun 1982
[6.18]	G004L/M024B/D160B-A	30 May 1980
[6.19]	G004L/M024B/D160B-B	30 May 1980
[6.20]	G004L/M024B/D160B-C	5 Nov 1981
[6.21]	G019F/D160B	8 Sep 1982
[6.22]	G033B/D160B	12 Jul 1982
[6.23]	G072D/BDN/D160B-A	19 Apr 1982

MEMORANDA OF AGREEMENT
FOR SYSTEM INTERFACES (Continued)

Ref. No.	Memorandum No.	Date
[6.24]	H036B/RC/D160B-A	10 Feb 1981
[6.25]	H069R/M024B/D160B-B	19 Jan 1981
[6.26]	0013/BDN/D160B	22 Jul 1982

Attachment 1: Proposed DAR Entries Supporting Modification of Maintenance Data Collection System to Transmit Civilian and Military Manhours Separately to AFLC.

Requirement

Currently, base level files of the Maintenance Data Collection System include a field called "category of labor," which distinguishes military from civilian manhours. Records transmitted to the Product Performance System at AFLC do not distinguish military from civilian manhours.

The current format of transmitted records involves 80 columns, all of which are used. However, a change in coding would permit distinguishing military and civilian manhours.

Column 80 of transmitted records is called "Record Code." Table A-1 identifies all values currently used. Of these records, only A, E, F, G, H, and S provide manhours. These codes should be reserved for military manhours, and additional codes (e.g. B, C, D, J, K, and U) used for civilian manhours in corresponding cases.

Request that record transmittal formats be changed to permit distinguishing military from civilian manhours.

Impact Statement

Failure to implement makes it impossible for the Product Performance System to provide military and civilian manhours separately to the CSCS. The CSCS in turn will remain unable to distinguish military and civilian labor costs.

TABLE A-1. RECORD CODES TRANSMITTED TO PRODUCT PERFORMANCE SYSTEM

Code	Application
A	On-equipment aircraft, missile and JETD C-E maintenance
E,F	On-equipment engine maintenance
G	On-equipment non-airborne maintenance
H	Off-equipment maintenance
L	Lead-the-force report
P	Parts replaced during repair
R	Removal of serialized components
S	Summarized aircraft support general
T	Removal/installation of aircraft engine

Justification Benefits/Cost Savings

Critically required to permit the CSCS to accurately portray labor costs and to maintain the congruence of the algorithm output with the input data.

Attachment 2: Proposed DAR Entries Supporting Modifications to Product Performance System to Process Civilian and Military Manhours Separately.

Requirement

Currently, the Product Performance System receives from the Maintenance Data Collection System reports on maintenance manhours which do not distinguish between civilian and military labor. A separate DAR, provided with this report as Attachment 1, proposes a data format incorporating this distinction.

Request that the Product Performance System be modified to accept inputs coded as described in Attachment 1. These reports would be forwarded to the CSCS in the new format.

Impact Statement

Failure to implement makes it impossible for the Product Performance System to provide military and civilian manhours separately to the CSCS. The CSCS in turn will remain unable to distinguish military and civilian labor costs.

Justification Benefits/Cost Savings

Critically required to permit the CSCS to accurately portray labor costs and to distinguish military from civilian costs, thus contributing to management decisions on economical maintenance.

Attachment 3: Proposed DAR Entries Supporting Modifications to CSCS to Process Military and Civilian Manhours Separately.

Requirement

Currently, the CSCS receives from the Product Performance System reports on maintenance manhours which do not distinguish between civilian and military labor. A separate DAR, provided with this report as Attachment 1, proposes a data format incorporating this distinction. A second DAR proposes that the Product Performance System forward to the CSCS the reports in the proposed modified format.

Request that the CSCS be modified to accept the reports in this format, and apply military and civilian pay rates to the respective manhours. The separate results should replace the TCTO labor data displayed in the MDS Logistics Support Costs Report, the Base WUC Cost Report, the Total Base WUC Cost Report, the Total Base and Depot WUC Cost Report and the Summary of Cost Elements Report.

Impact Statement

If not implemented, CSCS users will continue to get reports of TCTO labor costs that this analysis considers inaccurate.

Justification Benefits/Cost Savings

Critically required to permit the CSCS to accurately portray TCTO labor costs.

Attachment 4: Derivation of interpolation formulas for inflation factors

Inflation factors published in ARF 173-13 are annual values. Experience shows that these factors are most accurate at mid-year. For CSCS purposes, we need factors applicable to mid-quarter.

Figure A-1 illustrates the linear interpolation procedures. The published inflation factors at the mid-points of fiscal years X-1, X and X+1 are indicated by F(X-1), F(X), and F(X+1). The desired inflation factors at the mid-points of the quarters of fiscal year X are designated a, b, c, and d.

From the time of applicability of the value F(X-1) to the times of applicability of values a, b, and F(X), respectively, the elapsed times are $7\frac{1}{2}$, $10\frac{1}{2}$, and 12 months. Clearly, then,

$$a = F(X-1) + \frac{7\frac{1}{2}}{12}\,[F(X) - F(X-1)]$$

$$= F(X-1) + \frac{15}{24}\,[F(X) - F(X-1)]$$

$$= F(X-1) + \frac{5}{8}\,[F(X) - F(X-1)]$$

$$= \frac{5\,F(X) + 3\,F(X-1)}{8}.$$

Similarly,

$$b = F(X-1) + \frac{10\frac{1}{2}}{12}\,[F(X) - F(X-1)]$$

$$= \frac{7\,F(X) + F(X-1)}{8}.$$

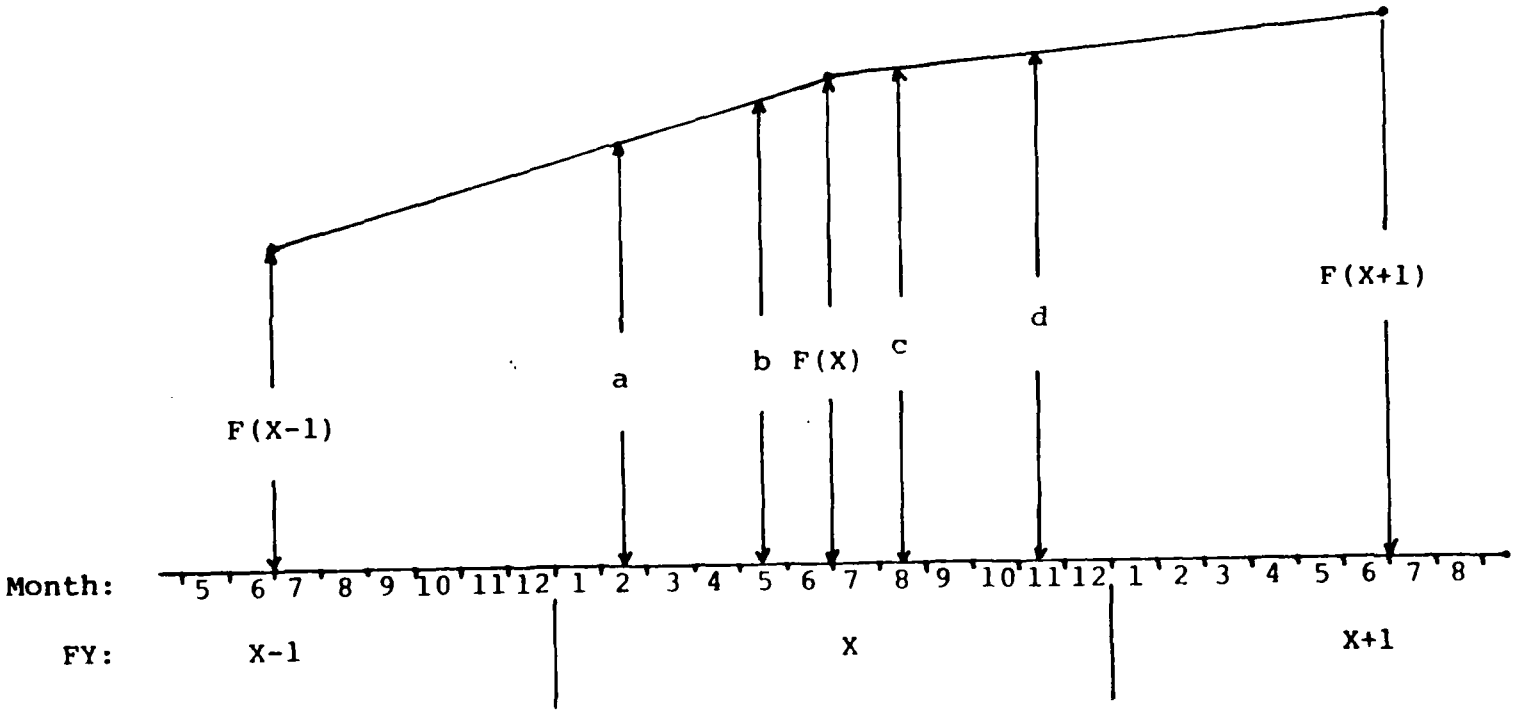

Figure A-1. Linear Interpolation for Inflation Factors

$$c = F(X) + \frac{1\frac{1}{2}}{12} [F(X+1) - F(X)]$$

$$= \frac{7\ F(X) + F(X+1)}{8}.$$

$$d = F(X) + \frac{4\frac{1}{2}}{12} [F(X+1) - F(X)]$$

$$= \frac{5\ F(X) + 3\ F(X+1)}{8}.$$

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study is the first of a set of reports documenting the findings of a study conducted by Information Spectrum, Inc (ISI) for the Office of VAMOSC, Air Force Logistics Command. This study constitutes an assessment of the algorithm for the Base TCTO Cost employed in within the Component Support Cost System (CSCS) subsystem of VAMOSC, the Air Force Visibility and Management of Operating and Support Cost system. CSCS deals with subsystem and components for aircraft.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. The costs of direct labor performed in maintenance of aircraft is a major component of support costs. This maintenance includes activities in response to Time Compliance Technical Orders (TCTOs), which are directives issued to provide instructions to Air Force activities for accomplishing "one-time" changes, modifications, or inspections of equipment or installation of new equipment. The CSCS algorithm for Base TCTO Labor Cost calculates and presents TCTO labor costs separately from other direct labor costs. These costs are developed for each combination of aircraft MDS and base.

This volume presents ISIs conclusions and recommendations, and the comments of the Office of VAMOSC.

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